ASSESSMENT OF LAKE TROUT BACKCROSS IN SOUTHERN GEORGIAN BAY, 1986

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ABSTRACT

Annual index gillnetting for lake trout backcross in southern Georgian Bay showed continued high abundance of the backcross population in 1986. Biomass (kg per 1000 m of gillnet), mean weight and mean age continued to increase, as has been observed each year since 1983. Catch-at-age of backcross planted in 1985 and 1986 has been lower than for preceding cohorts, suggesting poorer survival at stocking, possibly resulting from increased predator abundance (burbot and large backcross). Age groups >2 yr have steadily increased in abundance since the implementation of harvest controls in 1984. Estimates of total annual mortality beyond age 2 ranged from 13% to 58% (compared with >90% prior to controls), and generally increased with age. The catch rate from fry emergence trapping in spring 1986 was 0.030 per trap-night (14 fry in total), vs. 0.010 in 1985. Increased abundance, mean size and mean weight of spawners are expected to provide continued improvement in the extent of natural reproduction.

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INTRODUCTION

Plantings of F_1 yearling lake trout backcross ((*Salvelinus fontinalis* X *S. namaycush*) X *S. namaycush*) have been made annually in southern Georgian Bay since 1979, to re-establish a self-sustaining population of a lake trout-like species. The backcross genotype was chosen for its faster growth and earlier maturity compared with lake trout, *S. namaycush* (see Spangler and Berst 1976). Early maturation was considered necessary to ensure that sufficient numbers of fish would survive to maturity despite mortality from fishing and residual lamprey stocks. Lake trout planted in South Bay during 1949-1955 were virtually eliminated by lamprey before females attained maturity at age 7 (Budd and Fry 1960).

Plantings of the F_4-F_6 select splake hybrid (*S. fontinalis* X *S. namaycush*) during 1969-1977 had not produced an adequate population for rehabilitation (LHFAU 1979). Following improvements in hatchery rearing and planting methods at the start of the backcross program, the production and post-stocking survival of backcross were expected to be much better than had been true of the splake.

This report summarizes the results of the 1986 assessment program for lake trout backcross in southern Georgian Bay, including discussion of changes in abundance, age structure, and estimated mortality rates during the 1979-1986 period.

PLANTING AREAS AND ASSESSMENT SITES

A summary of the numbers stocked each year at each site in southern Georgian Bay is presented in Table 1. Not listed are backcross plantings

in the Heywood Island area of the eastern North Channel (1978, 1980-1986), as well as separate plantings made in South Bay, Manitoulin Island (for a research project comparing backcross and lake trout) and in Parry Sound, where rehabilitation of a native lake trout stock is under way.

Some experimental plantings have been incorporated into the southern Georgian Bay rehabilitation program, including: (i) a study of the effect of planting date and size at planting, during 1979-1981 at the Cape Rich site; and (ii) a paired planting experiment involving lake trout and backcross, begun in 1986, in Owen Sound bay. Preliminary results of the latter experiment are included in Appendix 1.

Assessment activities have primarily been graded-mesh gillnetting projects, carried out annually by the Lake Huron Fisheries Assessment Unit (LHFAU). The most intensive and longest-running project has been the index gillnetting program at Cape Rich, which has been conducted every August from 1973 to the present. A second assessment netting project was begun in Owen Sound bay in 1984, primarily to examine the backcross population in an area that had been free of commercial exploitation for three years. In addition, some surveys of spawning and fry emergence have been carried out in the Owen Sound and Meaford areas of southern Georgian Bay. Included in this report are results of the Cape Rich and Owen Sound gillnetting projects, and current progress regarding reproduction of backcross in the wild.

METHODS

Index gillnetting for backcross (and originally for the splake genotype) has been performed annually during late summer when thermal stratification tends to concentrate the fish in the thermocline. Two

gillnet gangs were fished daily, at one location off the the east side of Cape Rich. Each gang comprised two series of eight mesh sizes from 38 mm to 127 mm, in 12.7 mm intervals (1.5 to 5.0 inches, by 0.5 in increments), assembled in order of mesh size. Each mesh size panel was 91 m (100 yd) long, except for the 38 mm panels which were just 46 m (50 yd) in length. Total length of each gang was 1372 m, or 1500 yd.

Nets were made using two-strand nylon twine (210/2), hung "on the half" (i.e., 200 yd of twine was hung on 100 yd of side-line to assemble a 100 yd panel). Numbers of meshes deep for each panel were such that the nets were about 1.8 m high when fishing.

Nets were set parallel to each other, about 0.5-1.0 km apart. Set orientation alternated daily between perpendicular to shore and parallel to shore. Depths were determined according to the temperature profile taken by bathythermograph prior to setting. A target temperature of about 12 C (at lake bottom) served to guide the selection of fishing depth, along with the exercise of some judgement in predicting subsequent shifts in the thermocline based on wind conditions.

Fishing effort was originally set at 20 days of net lifts, but was cut back to 14 days in 1980, and to 10 days in 1984, in response to increasing catches of backcross. Total yardage of gillnet was therefore 60,000 yd, then 42,000 yd, and most recently 30,000 yd for the project. When compiling catch per unit effort data (CUE), the effort was adjusted for occasional two-night sets caused by weather conditions. CUE-at-age was also corrected for mesh panel length by doubling the catches from the shorter panels of 38 mm mesh size.

The design for the Owen Sound netting project differed somewhat from that for Cape Rich. Four sites within the bay were fished twice during each year's operation, but only one gang was set at a site at any one time, as opposed to the two gangs used at Cape Rich. Because of the varying

slope among the four sites, all nets were set along a given depth contour (corresponding to the target temperature of 12 C), roughly parallel to shore. Total effort was four days of net lifts, at two gangs (and two sites) per day, for a total of 12,000 yd of gillnet.

All lake trout backcross captured were retained for sampling in the laboratory, involving measurement of fork length, total length and round weight, and recording of fin clip, lamprey marks, sex, maturity, and stomach contents (count and identity). Scale samples were collected to permit age assignment where there was no discernible fin clip or where the fin clip corresponded to more than one possible age.

RESULTS

Catch composition

The 1986 catches by mesh size for all species at Cape Rich and Owen Sound are listed in Tables 2 and 3. In both cases, the backcross was the most frequently caught species, while rainbow smelt, longnose suckers, white suckers, bloater and yellow perch were also caught in sizable numbers. Burbot and alewife figured fairly prominently in the Owen Sound catches.

Catch rates for all species in index gillnets at Cape Rich are shown in Table 4, for the 1979-1986 period. Smelt CUEs have been quite variable from year to year, from a high of 111.28 (per 1000 m) in 1980 to a low of 28.76 in 1984. The CUEs for longnose suckers have been greater in the last three years than in the previous five years, but have remained well below those for white suckers. The recent rise in bloater and perch CUEs has been the result of a strong 1983 year class for both species (Hughes 1986). Similarly, a strong 1982 cohort of lake whitefish boosted that

species' CUE during 1984-1986. Apparent abundance of burbot has increased by an order of magnitude since 1979, consistent with observations elsewhere in the lake (Hughes 1986). The CUE for chinook salmon remained fairly constant (and low) during 1980-1985, then was sharply higher in 1986. A greater CUE (8.2 per 1000 m) for chinook was obtained near Collingwood during August 1986 (R. Craig, pers. comm.).

Table 5 contains the 1984-1986 CUEs for all species from the Owen Sound gillnetting program. The declining catch rate for backcross is discussed later in regard to the age structure of the backcross population. Contrary to the Cape Rich data, the longnose sucker CUEs have been greater than those for white sucker. The smelt CUEs followed a similar pattern to those at Cape Rich during the same years. Consistent increases in CUE were noted for alewife, burbot and yellow perch, while the bloater CUE jumped considerably in 1986. As observed at Cape Rich, both perch and bloater populations were increasing as a result of strong 1983 cohorts.

Backcross abundance and catch-at-age

Index gillnet CUEs for backcross are summarized in Table 6. The 1986 CUE in numbers at Cape Rich was up 6.7% from 1985, while the CUE in weight units increased 34.3%. Abundance has remained high and relatively stable since the implementation of harvest controls in 1984. Mean weight of backcross caught has increased each year, from 0.36 kg in 1983 to 1.70 kg in 1986 at Cape Rich. Catch rates for the splake hybrid planted prior to 1978 had ranged from <1 to 7 per 1000 m (LHFAU 1979), compared with CUEs of 27 to 76 for the backcross since 1979.

Age distributions for the 1986 projects were compiled from the prorated age distributions by mesh size (Tables 7 and 8). Backcross aged 3 and 4 were most prominent at both Cape Rich and Owen Sound. CUEs for fish of age >4 were similar at both locations. The catch rate for two-year-old

backcross in Owen Sound was about twice that at Cape Rich; no explanation is offered to account for the difference, as neither numbers stocked nor size at planting for that cohort had been particularly different from those of other years. The lower CUE for yearlings in Owen Sound (see also Table 9) reflects the change in backcross planting in that bay in 1986 due to the paired planting experiment, wherein half the fish stocked were lake trout.

As shown in the CUE-at-age summary for 1979-1986 (Table 9), the proportion of older backcross has risen each year since 1984. The upward shift in mean size and mean age has resulted not only from higher CUEs for older fish, but also from lower CUEs for age 1 and 2 backcross. Reduced survival of planted yearlings may have been caused by increased predator populations (burbot and large backcross), or by other factors, such as size at planting, temperature when stocked, etc. Examination of stomach contents of piscivorous fish in May 1986 in Owen Sound revealed that burbot had preyed intensively on backcross and lake trout planted 1 to 6 days earlier (Appendix B). Predation on planted trout by backcross and brown trout was also noted at that time.

Mortality estimates

Estimates of total annual mortality from August 1985 to August 1986 (Table 10) ranged from 13% to 53% at Cape Rich, and 26% to 58% in Owen Sound. No estimate could be made for age 2 to 3 at Cape Rich because the 1986 CUE for that cohort was greater than the 1985 CUE. Similarly, the high age 4 CUE at that location in 1986 resulted in the unrealistically low estimate of 13% mortality from age 3 to 4. The estimates for ages 4 to 5 and 5 to 6 (both 53%) are close to the 1985 figures (49% and 54% respectively). The very low estimate of 17% for age 6 to 7 was based on only a few samples, and was accordingly imprecise. Prior to implementation

of harvest controls in 1984, estimated total mortality often exceeded 90% beyond age 2 (LHFAU data), so the current mortality estimates signify considerable improvement in survival.

Growth, maturity and diet

Tables 11 and 12 show size-at-age data for the backcross caught in August 1986 at Cape Rich and Owen Sound, respectively. The variability in growth rate is clearly indicated, with each age class from 2 to 5 yr spanning 18-32 cm in fork length distribution. Age 3 fish were significantly smaller in Owen Sound than at Cape Rich ($p<0.0001$ for both males and females), apparently not as a result of original size at planting (48 and 54 g for Owen Sound lots; 36 g for Cape Rich). Other age groups did not exhibit the same divergence in size, and no hypothesis is offered to account for the observation.

Maturity data by size and age are compiled in Table 13 and 14 for the two sampling locations. In terms of size (both areas combined), 50% maturity for males occurred at about 42 cm FL, and for females at about 48 cm. Maturity by age for males (again combining both locations) was 81% at age 3 and 97% at age 4; the corresponding figures for females were 37% and 94% respectively. Percent maturity for three-year-old backcross in Owen Sound was lower than at Cape Rich (66 vs 87% for males; 25 vs 46% for females) because of the size difference for that cohort at the two locations.

Stomach contents of backcross and burbot from the Cape Rich and Owen Sound netting projects are summarized in Table 15. As has been observed in previous years (LHFAU data), smelt were the primary prey of backcross, with minor consumption of sticklebacks, alewives and sculpins. The large cladoceran zooplankton, Bythotrephes cederstroemi (a recent "invader" from Europe: see Lange and Cap 1986; Bur et al. 1986), was likely misidentified (as insects?) in backcross stomachs at Cape Rich, but its presence was

confirmed during the Owen Sound netting. It was extremely abundant during 1986 in Lake Huron and Georgian Bay, and also in Lake Erie (S. Nepszy, pers. comm.).

Burbot also relied heavily on smelt, although to a lesser extent in Owen Sound, where sculpins and crayfish were encountered in 7% and 11% of the burbot examined. The cladoceran B. cederstroemi was also noted in burbot stomachs.

Results of a special diet study carried out in spring 1986 are presented in Appendix B, showing predation on newly stocked backcross and lake trout by burbot, backcross and brown trout.

Reproduction

The first backcross fry caught in emergence traps were captured in spring 1985 at a spawning site in Owen Sound bay. Three fry were collected that year, followed by fourteen fry in spring 1986. Table 16 shows the catch rates and fry densities from the emergence trapping operations for both years. The increased capture success and density may have at least partially resulted from better placement of the fry traps in 1986, but the greater abundance of spawners (Table 9) presumably contributed to higher fry production.

All fry obtained were sent to the OMNR Fisheries Research laboratory at Maple. Electrophoretic analyses were conducted on 8 fish that died during or after shipment, to determine the relative proportions of brook trout and lake trout proteins in the wild fish. The other 9 fish (1 from 1985, 8 from 1986) are still alive at the research facility. Also being reared at Maple are about 30 F_2 backcross resulting from a spawn-taking operation at Meaford in fall 1985. Spawn-taking had also been performed at that site in 1983 and 1984, the purpose of the research study being to monitor fertilization, hatching, development and genetic make-up of

backcross progeny (P. Ihssen, pers. comm.).

Another milestone in the rehabilitation program will be the confirmed capture of wild-produced backcross in index gillnets. Because apparently unclipped fish occur annually in the catches because of fin regeneration, considerable numbers of young backcross without fin clips will have to be encountered to provide conclusive evidence of significant natural reproduction by planted backcross.

During the 1986 netting, 4 backcross at Cape Rich and 8 more from Owen Sound were recorded as having no discernible fin clips. Table 17 shows the age distribution of the unclipped fish. Assuming no between-year variation in fin clipping quality at the hatchery, fin regeneration would cause the proportion of "unclipped" fish in a cohort to increase with age. That trend was observed for age classes 3 to 6, but the percentage for age 2 backcross was greater than those for ages 3 and 4, suggesting that at least two of the three unclipped two-year-olds had never been fin clipped, and may have been wild fish. If so, then more unclipped two-year-old backcross should be expected in 1987, on the basis of increasing spawner abundance during the past three years. Yearling wild fish would not likely recruit to the index gillnets because of slower growth in their first year compared with hatchery fish (Casselman 1986).

Lamprey marking

The lamprey marking rates on the 2,740 backcross caught in August 1986 at Cape Rich and Owen Sound were 1.72 wounds per 100 fish and 3.10 scars per 100 fish. The incidence of marking was greater on backcross caught at Cape Rich than those from Owen Sound (Table 18), possibly because of the larger mean size of fish from the Cape Rich catches. The observed wounding rate is much lower than those encountered for lake trout in the western North Channel and in the Huron basin (>10% wounding in 1986; LHFAU data).

No lamprey marks were recorded from fish of any other species at either location in 1986.

SUMMARY

Index gillnet CUEs (in numbers of fish) for lake trout backcross remained high in 1986, while CUEs in weight units rose by 4% in Owen Sound and 34% at Cape Rich. Mean age at both locations was greater than 3 yr, and mean weight was about double the 1984 level. Abundance of backcross of age $\geq$4 yr continued to increase. Estimates of total annual mortality after age 2 remained below 50% up to age 4, and about 53-58% thereafter, compared with estimates exceeding 90% prior to fishery controls.

Abundance of younger fish has declined, however, as lower CUEs were obtained for cohorts planted in 1985 and 1986. Increased losses to predation may account for that trend, as predator abundance (burbot and large backcross) has risen substantially in recent years. Consumption of trout stocked in spring 1986 was observed shortly after planting, and burbot especially were found to have fed intensively on the planted fish.

As in previous years, considerable variability in backcross growth rate was noted, with each age class typically spanning a range of >20 cm in fork length. Some fish attained sizes of 46 cm at age 2 and 60 cm at age 3, and weights of 1.5 kg and 3 kg respectively.

Eighty-one percent of age 3 males, and 37% of age 3 females, were mature. By age 4 the figures were 97% and 94% respectively. These maturation rates, combined with the increasing abundance of fish $\geq$4 years old, indicate that the spawning stock was likely much stronger in fall 1986.

Successful reproduction of backcross in the wild was verified by fry

collections in 1985 and 1986. Capture rate increased three-fold in 1986 over the previous spring. The number of apparently unclipped two-year-old backcross caught in the index gillnets in 1986 was higher than would be expected from fin regeneration, suggesting that recruitment of wild fish did occur.

Lamprey marking rates were low (<2 wounds per 100 fish), confirming the low incidence of lamprey in southern Georgian Bay.

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Table 1. Planting statistics for yearling lake trout backcross stocked in southern Georgian Bay, 1979-1986.

Planting site	1979	1980	1981	1982	1983	1984	1985	1986
Mary Ward Shoal	182,176	10,000	101,531	122,147	107,770	136,617	121,348	126,559
Boucher Pt.		42,212	33,155	34,846	30,057	53,572	48,588	54,743
Meaford Harbour							31,430	
Cape Rich	108,423	123,544	120,180	100,095	97,087	130,463	115,925	123,304*
Vail Point		81,037	39,781	122,550	84,842	118,275	102,689	25,509
Coffin Cove								25,377
Sutton Point								25,388
Pyette Point	130,558	69,157	73,460	101,025	101,560	127,864	107,957	25,354
North Keppel	28,063				3,584		12,853	6,004
White Cloud I.		60,727	64,469	31,441	21,006	37,096	12,781	13,485
Griffith I.				78,178	69,038	17,415	6,391	12,605
Cameron Point							17,762	27,058
Colpoys dock							6,396	
Cape Dundas		52,930	27,493	38,548	18,923	17,814	6,396	
Jackson Shoal	142,458	50,908	36,820	47,405	68,885	44,235	25,417	45,055
Lion's Head dock	11,113							
Total numbers	602,791	490,515	496,889	676,235	602,752	683,351	615,933	510,441
Weight (kg)	34,359	25,997	26,335	28,402	33,151	31,434	24,021	23,991

An additional release of 63,188 fall fingerlings occurred in October 1983 at Dyer's Bay, north of Lion's Head. This was an unscheduled planting of fish whose transfer to the Sandfield hatchery on Manitoulin Island was interrupted by a weather delay while on board a ferry; the fish were released when the oxygen supply neared depletion.

*Not shown in the 1986 plantings are 100,671 lake trout stocked in Owen Sound (Vail Pt., Coffin Cove, Sutton Pt. and Pyette Pt.) as part of a paired planting experiment.

Table 2. Total catch by mesh size from index gillnetting at Cape Rich, August 1986.

Species	Mesh size (mm)								Total	CUE (no./ 1000m)
	38	51	64	76	89	102	114	127		
sea lamprey		1		1		1		1	4	.15
alewife	46	28							74	2.70
chinook salmon	22	7	1	3	1	1	1		36	1.31
rainbow trout	4	2	1						7	.26
backcross	121	295	265	247	267	269	240	210	1914	69.77
lake whitefish	1	8	5	9	17	33	25	36	134	4.88
bloater	316	129	13	14	10	7	7	3	499	18.19
round whitefish	3	3	5	1	2				14	.51
rainbow smelt	148	305	278	227	151	78	46	38	1271	46.33
longnose sucker	6	39	72	108	147	41	4	2	419	15.27
white sucker	18	223	429	559	390	40	2	1	1662	60.59
lake chub	35								35	1.28
burbot	1	4	7	16	17	21	19	11	96	3.50
yellow perch	222	308	8	1					539	19.65
Totals:	943	1353	1085	1186	1002	491	344	302	6706	244.46

Table 3. Total catch by mesh size from index gillnetting in Owen Sound bay, August 1986.

Species	Mesh size (mm)								Total	CUE (no./ 1000m)
	38	51	64	76	89	102	114	127		
alewife	254	13		1					268	24.4
chinook salmon	1	6			1		1		9	0.8
rainbow trout		1							1	0.1
brown trout		1				2			3	0.3
lake trout	1								1	0.1
backcross	40	106	143	136	101	110	96	94	826	75.3
lake trout sp.	1								1	0.1
lake whitefish		2		3	2	4	4	10	25	2.3
bloater	336	202	15	14	7	3	3	2	582	53.0
round whitefish		1	3	1					5	0.5
rainbow smelt	72	201	156	96	59	44	35	11	674	61.4
longnose sucker	4	36	55	89	132	36	4	1	357	32.5
white sucker	1	11	36	75	105	14	1		243	22.1
lake chub	9		1						10	0.9
burbot	2	16	58	55	79	55	23	13	301	27.4
yellow perch	334	175	7	1					517	47.1
Totals:	1055	771	474	471	486	268	167	131	3823	348.4

Table 4. Index gillnetting CUEs (no/1000 m) at Cape Rich, 1979-1986. (Not adjusted for shorter length of 38 mm mesh panels.)

Species	1979	1980	1981	1982	1983	1984	1985	1986
sea lamprey	0.02	-	0.02	-	-	0.03	-	0.15
alewife	2.08	5.78	5.59	3.88	17.00	0.06	1.86	2.70
pink salmon	-	-	0.02	-	0.03	-	0.03	-
coho salmon	-	0.05	-	-	-	-	-	-
chinook salmon	0.04	0.21	0.53	0.36	0.52	0.27	0.36	1.31
rainbow trout	-	-	0.12	0.05	0.18	0.18	0.10	0.26
brown trout	-	-	0.02	0.03	-	0.06	-	-
brook trout	-	-	0.02	-	-	-	-	-
lake trout backcross	27.41	76.37	39.50	35.58	33.97	73.29	65.35	69.77
lake whitefish	3.52	8.28	1.48	2.66	1.77	6.07	7.79	4.88
lake herring	0.05	0.10	0.27	0.10	-	0.06	-	-
bloater	3.94	9.35	4.03	8.85	1.82	6.13	32.34	18.19
round whitefish	0.16	0.26	0.17	0.29	0.21	0.39	0.46	0.51
rainbow smelt	42.97	111.28	53.50	83.87	32.72	28.76	60.75	46.33
longnose sucker	4.65	8.56	5.73	8.30	10.91	33.83	16.47	15.27
white sucker	35.44	71.09	110.50	63.52	60.47	85.13	53.16	60.59
lake chub	1.26	1.80	1.43	2.81	2.58	2.13	0.50	1.28
carp	0.02	-	0.02	0.03	-	-	-	-
burbot	0.49	0.89	0.49	2.00	2.52	3.01	4.71	3.50
trout-perch	-	-	-	-	-	0.03	-	-
rock bass	-	-	0.02	-	-	-	-	-
smallmouth bass	0.02	-	-	-	-	-	-	-
yellow perch	0.84	1.56	26.29	4.27	1.25	12.12	19.12	19.65
Total CUE	114.27	295.58	249.78	216.55	165.95	251.46	263.00	244.46
Effort (x 1000 m)	54.86	38.40	41.15	38.40	38.40	32.92	30.18	27.43

Table 5. Index gillnetting CUEs (no/1000 m) at Owen Sound, 1984-1986. (Not adjusted for shorter length of 38 mm mesh panels.)

SPECIES	1984	1985	1986
sea lamprey	-	0.2	-
alewife	0.3	7.2	24.4
chinook salmon	0.3	1.2	0.8
rainbow trout	0.1	0.1	0.1
brown trout	0.5	0.3	0.3
lake trout	-	-	0.1
lake trout backcross	106.9	91.1	75.3
lake trout sp.	-	-	0.1
lake whitefish	7.7	2.8	2.3
bloater	12.0	10.6	53.0
round whitefish	0.5	0.3	0.5
rainbow smelt	47.2	109.1	61.4
longnose sucker	39.4	54.0	32.5
white sucker	28.4	32.4	22.1
lake chub	2.2	3.0	0.8
burbot	13.0	23.4	27.4
yellow perch	8.3	22.3	47.1
TOTAL C.U.E.	266.7	358.1	348.4

Table 6. Summary of index gillnet catches of lake trout backcross at Cape Rich, 1979-1986, and Owen Sound, 1984-1986.

	Project year	Number caught	CUE		Mean weight (kg)
			No/1000m	Kg/1000m	
Cape Rich					
	1979	1504	27.4	6.2	0.23
	1980	2934	76.4	24.9	0.33
	1981	1626	39.5	13.1	0.33
	1982	1365	35.6	31.2	0.88
	1983	1305	34.0	12.1	0.36
	1984	2410	73.3	53.4	0.73
	1985	1972	65.4	88.3	1.35
	1986	1914	69.8	118.6	1.70
Owen Sound					
	1984	1173	107.0	80.0	0.75
	1985	875	91.1	106.9	1.17
	1986	826	75.3	111.4	1.48

Table 7. Age distribution by mesh size for lake trout backcross from index gillnetting at Cape Rich, August 1986. (Prorated for length of 38 mm mesh panels.)

Mesh size (mm)	Age (yr)							Total
	1	2	3	4	5	6	7	
38	168	20	22	26	6			242
51	115	61	46	61	9	2	1	295
64	22	66	78	77	21	1		265
76	5	52	77	98	13	1	1	247
89	3	24	99	123	15	3		267
102	4	9	105	126	23	2		269
114	1	5	97	115	17	4	1	240
127	2	12	72	105	16	3		210
Total:	320	249	596	731	120	16	3	2035
CUE:	10.94	8.51	20.37	24.98	4.10	0.55	0.10	69.55

Table 8. Age distribution by mesh size for lake trout backcross from index gillnetting at Owen Sound, August 1986. (Prorated for length of 38 mm mesh panels.)

Mesh size (mm)	Age (yr)							Total
	1	2	3	4	5	6	7	
38	44	14	12	4	2	4		80
51	18	48	21	15	4			106
64	3	59	53	19	7	1	1	143
76	1	37	57	32	7	1	1	136
89	1	16	53	23	6	1	1	101
102		9	53	40	6	2		110
114		7	33	43	9	4		96
127	1	8	38	36	8	2	1	94
Total:	64	198	320	212	49	15	4	866
CUE:	5.47	16.92	27.34	18.11	4.19	1.28	0.34	73.99

Table 9. CUE-at-age summary for lake trout backcross from index gillnetting at Cape Rich, 1979-1986, and Owen Sound, 1984-1986.

Year	Age (yr)							Total CUE	Mean age
	1	2	3	4	5	6	7		
Cape Rich									
1979	27.5	-	-	-	-	-	-	27.5	1.00
1980	67.1	14.4	-	-	-	-	-	81.5	1.18
1981	32.7	8.3	0.7	-	-	-	-	41.8	1.23
1982	4.4	25.6	4.6	0.6	-	-	-	35.1	2.05
1983	23.6	10.2	2.1	0.2	0.0	-	-	36.2	1.41
1984	22.61	36.10	13.91	2.29	0.26	0.00	-	76.11	1.93
1985	8.54	18.42	28.61	8.51	1.18	0.12	0.00	65.40	2.63
1986	10.94	8.51	20.37	24.98	4.10	0.55	0.10	69.55	3.07
Owen Sound									
1984	13.24	61.52	21.02	3.25	0.43	0.00	-	100.22	2.16
1985	9.57*	36.81	34.47	9.96	0.78	0.00	0.00	91.59	2.51
1986	5.47*	16.92	27.34	18.11	4.19	1.28	0.34	73.99	3.04

* Backcross planting in 1986 was about half of previous level, due to matched planting of lake trout.

Table 10. Estimated total annual mortality for lake trout backcross from index gillnetting at Cape Rich and Owen Sound, 1986.

Year class	CUE		Estimated total mortality	(Ages)
	1985	1986		
Cape Rich				
1983	18.42	20.37	n.a.	(2 to 3)
1982	28.61	24.98	13%	(3 to 4)
1981	8.51	4.10	52%	(4 to 5)
1980	1.18	0.55	53%	(5 to 6)
1979	0.12	0.10	17%	(6 to 7)
Owen Sound				
1983	36.81	27.34	26%	(2 to 3)
1982	34.47	18.11	48%	(3 to 4)
1981	9.96	4.19	58%	(4 to 5)
1980	0.78	1.28	n.a.	(5 to 6)
1979	0.00	0.34	n.a.	(6 to 7)

Table 11. Fork length/age distribution of backcross sampled from index gillnetting at Cape Rich, August 1986.

FL class (cm)	Age (yr)							Total
	1	2	3	4	5	6	7	
16	8							8
18	35							35
20	45	6						51
22	75	6						81
24	39	11						50
26	29	19						48
28	5	25	1					31
30		45	1					46
32		39						39
34		36	6					42
36		18	7					25
38		12	14					26
40		13	21	5	1			40
42		5	37	6	2			50
44		2	59	12	2			75
46		2	102	26	3			133
48			102	52	8			162
50			105	103	4	1		213
52			68	116	14	2	2	202
54			45	132	17			194
56			10	101	17	1		129
58			6	83	20	3		112
60			1	49	17	4		71
62				26	6	1	1	34
64				6	4	2		12
66				1	2	1		4
68						1		1
Total:	236	239	585	718	117	16	3	1914
Mean FL(mm):	226	324	484	544	564	600	564	461
Mean wt(g):	128	458	1632	2468	2772	3354	2981	1701
Males								
Number:	120	136	388	341	53	3	1	1042
Mean FL:	230	328	481	541	554	600	536	456
Mean wt:	133	486	1602	2380	2500	3201	2546	1599
Females								
Number:	66	97	196	374	64	13	2	812
Mean FL:	228	322	489	546	568	600	578	483
Mean wt:	128	434	1673	2547	2958	3389	3199	1939

Table 12. Fork length/age distribution of backcross sampled from index gillnetting at Owen Sound, August 1986.

FL class (cm)	Age (yr)							Total
	1	2	3	4	5	6	7	
14	1							1
16	5							5
18	9							9
20	8							8
22	8	4						12
24	8	9						17
26	2	20	3					25
28	5	22	6					33
30		37	5					42
32		34	9					43
34		26	5	1				32
36		16	13	2				31
38		13	15	1				29
40		3	21	1				25
42		4	45	2				51
44		3	39	4				46
46			43	6	1	1		51
48			38	6	1	1		46
50			32	34	7	1		74
52			18	36	4	1		59
54			12	38	4			54
56			9	37	11	2		59
58			1	26	2	1		30
60				12	10	1	1	24
62				4	7	1	1	13
64					1	2		3
66						2	1	3
68								0
70							1	1
Total:	46	191	314	210	48	13	4	826
Mean FL(mm):	220	326	451	541	571	578	651	442
Mean wt(g):	123	460	1383	2440	2817	2917	3692	1486
Males								
Number:	23	109	167	89	25	5	2	420
Mean FL:	226	328	455	544	567	518	645	436
Mean wt:	130	448	1413	2454	2741	2242	3369	1411
Females								
Number:	19	79	144	121	23	8	2	396
Mean FL:	220	321	448	538	575	628	658	451
Mean wt:	127	417	1357	2430	2899	3635	4015	1589

Table 13. Size/maturity summary (numbers of fish) for lake trout backcross from index gillnetting at Cape Rich and Owen Sound, August 1986.

FL class (cm)	Males				Females			
	Cape Rich		Owen Sound		Cape Rich		Owen Sound	
	imm.	mat.	imm.	mat.	imm.	mat.	imm.	mat.
16	2		1		1		2	
18	17		3		8		5	
20	19		5		17		3	
22	44		8		23		4	
24	29		9		13		7	
26	26		13		20		11	
28	18		13		11		20	
30	25		26		21		16	
32	26		23		13		18	
34	19	3	19		19		13	
36	9	3	17		13		14	
38	12	9	11	1	5		16	1
40	14	12	11	2	10	4	11	
42	9	25	13	14	8	8	19	5
44	11	35	4	22	18	11	16	3
46	10	78	6	23	24	20	12	11
48	3	103	5	22	21	35	10	8
50	9	107		44	13	83	8	22
52	5	109		29	8	78	5	25
54	2	93	1	19	11	88	6	28
56	1	53	1	21	3	72	3	34
58	1	49	2	13	4	58		15
60		32		11	1	38	2	11
62	2	12		6		20		7
64		3		1		9		2
66		2		1		2	1	1
68						1		
70								1
Totals:	313	728	191	229	285	527	222	174

Table 14. Age/maturity summary (numbers of fish) for lake trout backcross from index gillnetting at Cape Rich and Owen Sound, August 1986.

Age (yr)	Males				Females			
	Cape Rich		Owen Sound		Cape Rich		Owen Sound	
	imm.	mat.	imm.	mat.	imm.	mat.	imm.	mat.
1	119		23		66		19	
2	131	5	108	1	97		79	
3	49	339	56	111	106	90	108	36
4	11	330	3	86	14	360	14	107
5	1	51	1	24	2	62	1	22
6	1	2		5		13	1	7
7		1		2		2		2

Table 15. Percent frequency (and counts of fish prey) for stomach contents of lake trout backcross and burbot from index gillnetting at Cape Rich and Owen Sound, August 1986.

Stomach contents	Backcross		Burbot	
	Cape Rich (n=1914)	Owen Sound (n=826)	Cape Rich (n=94)	Owen Sound (n=301)
Empty	35.6%	29.4%	31.9%	43.5%
Fish remains	44.4	36.9	44.7	23.9
Smelt	23.7 (2137)	37.4 (1251)	26.6 (79)	19.9 (138)
Stickleback	0.3 (6)	0.2 (3)		0.7 (2)
Alewife	0.1 (2)			
Sculpin	0.05 (1)		1.1 (1)	7.3 (40)
Backcross			2.1 (2)	
Burbot				0.3 (1)
Crayfish			3.2 (3)	10.6 (41)
Crustaceans	*	2.3	*	13.6
Insects	1.1	0.1	1.1	

* The crustacean Bythotrephes cederstroemi was present but not recorded as such during the Cape Rich project, but was recorded in Owen Sound.

Table 16. Results of fry emergence trapping for backcross in Owen Sound, 1985-1986.

Year	Number caught	C.U.E. (no/trap-night)	Density (no/m^2)
1985	3	0.010	0.75
1986	14	0.030	3.09

Table 17. Age distribution of backcross with no apparent fin clip, from index gillnetting at Cape Rich and Owen Sound, August 1986.

	Age (yr)						
	1	2	3	4	5	6	7
Total caught	282	430	899	928	165	29	7
No. "unclipped"	0	3	2	3	3	1	0
% "unclipped"	0.0	0.70	0.22	0.32	1.82	3.45	0.0

Table 18. Lamprey marking rates for backcross from index gillnets at Cape Rich and Owen Sound, August 1986.

	Cape Rich (n=1,914)	Owen Sound (n=826)
Wounds/100 fish:	1.83	1.45
Scars/100 fish:	3.45	2.30
Total:	5.28	3.75

APPENDIX A: PAIRED PLANTING EXPERIMENT

Lake trout and backcross yearlings stocked in Owen Sound in 1986 carried coded wire tags and were marked with an adipose fin clip. During the assessment netting, 19 of these fish were caught in Owen Sound and 6 at Cape Rich. One of the Owen Sound yearlings was a lake trout, and another had not retained its tag after injection, so it remained unidentified; all others were backcross. The scarcity of lake trout in the catches this year had been expected because their smaller size at planting would delay recruitment to the gear. The 1986 plant of lake trout should be fully recruited to the index gear by 1987.

Release and capture sites of the tagged backcross from the index catches are listed in Table A-1. Within Owen Sound bay, 10 of the 18 fish were captured at their respective release sites. The single lake trout had been released at Sutton Point and was captured at Pyette Point.

Table A-1. Release and capture sites of backcross yearlings from index gillnetting at Owen Sound bay and Cape Rich, August 1986.

Release site	Capture site				Owen Sound total	Cape Rich total
	Pyette Pt.	Sutton Pt.	Coffin Cove	Vail Pt.		
Pyette Pt.	1	0	0	0	1	0
Sutton Pt.	1	4	2	1	8	0
Coffin Cove	0	2	2	2	6	1
Vail Pt.	0	0	0	3	3	5
Total:	2	6	4	6	18	6

APPENDIX B: PREDATION STUDY IN OWEN SOUND

A brief gillnetting operation was conducted in Owen Sound in May 1986 to examine the extent of predation on newly stocked lake trout and backcross. Burbot abundance had increased ten-fold at Cape Rich since 1978, and appeared to be even greater in Owen Sound (see Tables 4 and 5). Numbers of large backcross had also grown since fishery controls were introduced, and enhancement of local populations of brown trout and chinook salmon was underway. Meanwhile, apparent survival of recent plantings of backcross had declined. In addition to concern about predation on planted backcross, further interest was prompted by the initiation of an experiment in Owen Sound bay aimed at comparing the performance of lake trout and backcross planted under identical conditions. Because of a size difference between the two genotypes at the time of planting, predation mortality, if it was occurring, could be more severe for one genotype.

This study examined the incidence of planted lake trout and lake trout backcross in the stomachs of large piscivores found near a planting site close to the time of planting.

Methods

Paired gangs of graded mesh gillnets were set overnight on the bottom at Coffin Cove, one of four sites stocked with yearling lake trout and backcross. Nets were set on May 21/86, when backcross were stocked; again on May 23/86 when lake trout were planted; and a third time on May 27/86, four days after completion of stocking. Two gillnet gangs were set on each occasion, parallel to each other and perpendicular to shore. Fishing depths ranged from 8 to 19 m, and bottom temperatures from 4 to 7 C. Each gillnet gang contained four 91 m panels of graded mesh sizes -- 89, 102, 114 and 127 mm.

All potential predators -- salmonines, burbot, and yellow perch -- were retained for sampling in the laboratory. Stomach contents were identified to fish species (where permitted by state of digestion) or to convenient invertebrate taxon, e.g., crayfish, mayflies, etc. Contents were itemized in the case of fish species or crayfish. Size information was recorded for all predators. Whenever lake trout or backcross were encountered in gut examinations, those specimens were frozen for subsequent extraction of coded wire tags. Tag lot numbers were used to establish genotype of the specimens.

Results

Numbers and size statistics of the predators caught are shown in Table B-1, along with a summary of frequency of occurrence of diet types, and counts of the fish and crayfish prey items. Most (84%) of the 262 predators were backcross, followed by burbot, yellow perch and brown trout. The 18 perch were large enough to be possible predators of small planted trout. While more backcross than burbot were found to have eaten planted trout (backcross and lake trout combined), those 16 backcross contained just 29 trout, compared with 11 burbot which had consumed 50 trout. Two brown trout together contained 4 planted trout, while no perch had eaten trout. In terms of frequency, stocked trout were found in 7% of the backcross, and 48% of the burbot.

Further evidence of the more intensive predation by burbot on the planted fish is given in Table B-2, showing the percent composition of diets represented by the itemized fish species and crayfish. Stocked trout made up only 5.7% of the identifiable ("macro") diet of backcross, but 51.5% of that for burbot. Smelt and alewives were the major prey of backcross, and crayfish and alewives were the second and third most frequent items for burbot. As shown in Table 15, smelt were the most common prey for both species in late summer.

Table B-3 contains the breakdown of predation on planted backcross vs. lake trout, identified by coded wire tags removed from the prey fish. All but one of the 54 identified trout had been stocked at the netting site. Total number of backcross eaten was higher than lake trout (38 vs. 16) because the former were planted earlier, (and were thus exposed to predation for a longer period than were lake trout), and the first net set preceded the planting of lake trout. The large proportion of trout prey that could not be identified (due to tag loss through digestion) prevents rigorous comparison of genotype preferences as prey. In any event, no overwhelming preference is suggested by the results, for the period immediately after stocking.

Table B-1. Frequency of occurrence of diet items in stomachs of predators examined from gillnetting in Owen Sound, May 1986. (Total counts of fish and crayfish are shown in parentheses.)

	Predator species			
	Backcross	Burbot	Brn. trout	Y. perch
Number caught	219	23*	2	18
Mean FL (mm)	475	528	419	307
FL range	142-635	424-658	374-463	267-364
Mean weight (g)	1651	1158	1006	480
Weight range	30-3660	584-2016	726-1286	286-798
Number empty	41	1	0	6
FISH				
remains	56	8	1	5
alewife	67 (105)	7 (10)	0	2 (2)
planted trout	16 (29)	11 (50)	2 (4)	0
smelt	101 (376)	1 (5)	1 (5)	2 (2)
sticklebacks	0	0	0	3 (3)
sculpins	1 (1)	3 (5)	0	3 (3)
OTHER				
crayfish	0	8 (27)	0	0
zooplankton	0	0	0	1
insects	1	0	1	0

* Burbot fork length = total length

Table B-2. Percent composition of predator diets (fish and crayfish only), from gillnetting in Owen Sound, May 1986.

Prey	Predator species			
	Backcross	Burbot	Br. trout	Y. perch
crayfish	0.0	27.8	0.0	0.0
alewife	20.5	10.3	0.0	20.0
planted trout	5.7	51.5	44.4	0.0
smelt	73.6	5.2	55.6	20.0
sticklebacks	0.0	0.0	0.0	30.0
sculpins	0.2	5.2	0.0	30.0

Table B-3. Consumption of planted trout by lake trout backcross, burbot and brown trout, from gillnetting in Owen Sound, May 1986.

Date	Predator species	Number examined	No. with trout prey	Number eaten		
				Backcross	Lake trout	unknown
May 21-22						
	Backcross	107	3	4	-	-
	Burbot	10	3	6	-	-
				Total: 10		
May 23-24						
	Backcross	65	9	10	3	4
	Burbot	3	2	8	6	6
	Brown trout	1	1	1	2	0
				Total: 19	11	10
May 27-28						
	Backcross	47	4	0	1	6
	Burbot	10	6	9	4	11
	Brown trout	1	1	0	0	1
				Total: 9	5	18
Totals:						
	Backcross	219	16	14	4	10
	Burbot	23	11	23	10	17
	Brown trout	2	2	1	2	1
				Total: 38	16	28